

**WHAT IS CLAIMED IS:**

1. A method for producing a semiconductor device including formation of an interlayer insulating film having a fluorine-doped silicon oxide layer on a substrate, the method comprising the steps of:

5 forming said fluorine-doped silicon oxide layer in a process chamber; and

forming a silicon oxide layer on said fluorine-doped silicon oxide layer in the same process chamber subsequent to the formation of said fluorine-doped silicon oxide layer, said silicon oxide layer being formed at  
10 a temperature higher than a film forming temperature of said fluorine-doped silicon oxide layer; thereby

forming said interlayer insulating film comprising said fluorine-doped silicon oxide layer and said silicon oxide layer formed thereon on said substrate.

15 2. The method for producing a semiconductor device according to claim 1, wherein

a film forming temperature of said silicon oxide layer is equal or less than 450 °C.

20 3. The method for producing a semiconductor device according to claim 1, further comprising the steps of:

forming an insulation layer on said silicon oxide layer; and

planarizing said insulation layer with a chemical mechanical  
25 polishing process or a plasma etching process from a surface side of said insulation layer without exposing said fluorine-doped silicon oxide layer.

4. A method for producing a semiconductor device including formation of an interlayer insulating film having a fluorine-doped silicon  
30 oxide layer on a substrate, the method comprising the steps of:

forming said fluorine-doped silicon oxide layer in a process chamber; and

removing a surface layer of said fluorine-doped silicon oxide layer by sputtering in the same process chamber subsequent to the formation of

said fluorine-doped silicon oxide layer

5. The method for producing a semiconductor device according to claim 4, further comprising the steps of:

5 forming an insulation layer on a surface layer of said fluorine-doped silicon oxide layer after the sputtering; and

planarizing said insulation layer with a chemical mechanical polishing process or a plasma etching process from a surface side of said insulation layer without exposing said fluorine-doped silicon oxide layer.

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